

TECHNICAL PROPOSAL

NEW VIEWING OPTICS FOR [REDACTED] COMPARATORS

22 February 1963

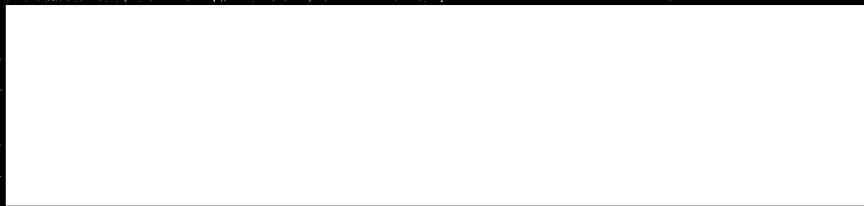


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1. INTRODUCTION

In response to the Request for Proposal No. 2040-63 of the Bureau of Naval Weapons, Department of the Navy, the [REDACTED] proposes to design, fabricate, and install binocular viewing systems in [REDACTED] Comparators No. 621006 and No. 88001 in accordance with this technical proposal. Accompanying this proposal is a letter of transmittal, the required cost estimate, and a fixed price quotation for the work.

The [REDACTED] proposes the use of optical components now commercially available with which the design objectives can be approximated but not precisely met. It is the opinion of the [REDACTED] that the advantage to be gained from this new system in setting accuracy and minimization of operator fatigue is not sufficient to justify the huge expense of specially designed optics, although the less expensive approach can be justified.

Two existing problems present themselves to make it difficult to perform this work. First, instrument No. 621006 has had installed on it a Ferranti moire' fringe reading system. This system would have to be removed before shipment of the instrument to [REDACTED] for installation of the new optical system. We recommend that the Naval Photographic Interpretation Center consider carefully the plans for removing and remounting the Ferranti system, the gratings of which must be positioned so precisely close to one another. Second, inspection of the instruments at NPIC by the Manager, the Engineering Manager, and the Product Development Manager of the [REDACTED] revealed damage in both instruments which can and perhaps are materially affecting their measuring accuracy.

In view of the above, the [REDACTED] must limit its proposal to the design, fabrication, and factory installation of the new optical systems. Repair

and recalibration and all handling of the Ferranti system are not within the scope of this proposal and its accompanying quotation. Packaging and transport to and from our factory and the cost thereof would necessarily be the responsibility of the Bureau of Naval Weapons. The [redacted] would not be responsible for in-transit damage. This quotation does not include reinstallation at NPIC by a factory representative. The [redacted] can separately quote on repairs and recalibration, but it can take no responsibility for performance of the one instrument after reinstallation of the Ferranti equipment. [redacted]

[redacted] have discussed with NPIC personnel the nature of the repairs that need be made for proper performance after their examination of the instruments.

2. COMMENTS ON DESIGN OBJECTIVES

2.1 Magnification

The binocular zoom pod of the [redacted] Dynazoom Optical System can adjust magnification between 1X and 2X, with dial calibration for each 0.1X. This certainly would not meet the 1X to 5X design objectives for the zoom pod. The range could be extended, however, with changes in eyepieces. With a 3.5X objective, a 5X eyepiece would give magnifications continuously variable between 17.5X and 35X. Changing to 10X eyepieces, 35X through 70X would be realized.

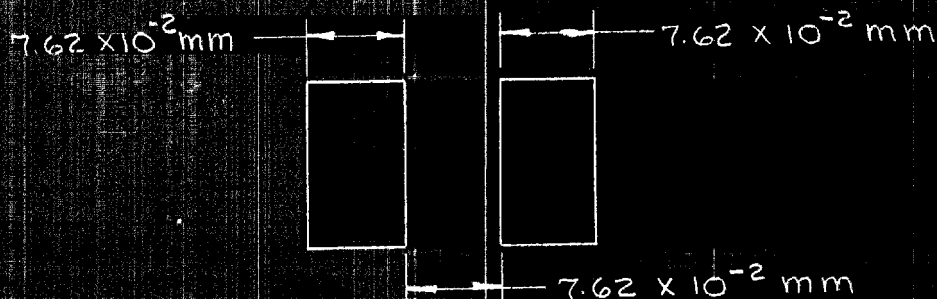
[redacted] also offers a 0.7X through 3X zoom pod, but this is a stereo system and not desirable for measurement purposes.

To use the non-stereo binocular zoom pod, detail design studies would be made to see if an approximately 0.57X relay pickup could be used. If possible, the magnification range would then be approximately 10X to 40X with a change in eyepieces. This seems feasible. In contract performance, the possibility of extending the zoom range, even a small amount, by [redacted] would be explored.

2.2 Resolution

The design goal of line pairs/mm equivalent to 8 times the magnification is probably beyond the "state-of-the-art." Most authorities state that the average human eye can resolve 1 min of arc at 10 in.

This calculates to a resolution of 7.62×10^{-2} mm limit for the human eye.



For line pairs, each pair would occupy 14.24×10^{-2} mm. In 1 mm, there are 7 pairs:

$$1 \text{ mm} \div \frac{14.24 \times 10^{-2} \text{ mm}}{\text{pair}} = 7 \text{ pairs}$$

The human eye can resolve as a limit 7 line pairs/mm. With M magnification, it could resolve 7 M line pairs/mm. This would be ideal. Present optical systems of the [] approximate more closely 5.5M to 6M. It is difficult, if not impossible, to specify a resolution for an optical system never assembled without extensive calculations, but a resolution of 5.5M seems to be a reasonable design goal. This resolution is being realized now on the [] comparators at NPIC, based on observations of standard Air Force resolution targets. Resolution will also be limited by the resolution of high quality American microscope optics.

2.3 Eyeiece Focus.

The [] system provides for a separate focus adjustment for the left ocular. The instrument is brought to focus for the right eye, followed by the ocular adjustment for the left eye.

2.4 Interpupillary Distance.

Provision is made by [] for interpupillary distance adjustment while maintaining constant tube length. There is no lock on the interpupillary distance. However, a slight change or readjustment should not affect the pointing accuracy since the reticle is located at a first focal plane which is being observed by the Dynazoom pod.

2.5 Fine Focus.

Fine focus would be achieved through motion of the entire optical system relative to the focal plane, although other arrangements may prove more satisfactory as revealed during the course of the development.

2.6 Reference Mark.

The design of the reference reticle will be determined upon consultation. It is the opinion of the [] that proper reticle design can be more effective in improving setting precision for a specific image type than any other optical approach. This could also apply to the present optical systems on the equipment. Provision for maintaining sharp focus of the reticle will be provided.

2.7 Illumination.

The design objective does not recognize the problem of deleterious effects from heat on measurement accuracy. The illuminating system proposed by [REDACTED] will not affect measurement accuracy, either through heating of the instrument or of the film plane.

2.8 Mounting on Existing Mounting Points.

The [REDACTED] cannot guarantee the complete use of existing mounting points. However, this should be no problem with factory installation.

3. DESIGN DETAILS

The [REDACTED] will approach this development in the manner described in this section, although deviations as dictated by the development work may be incorporated in the design.

3.1 Illuminating System.

The [REDACTED] proposes to use a high pressure mercury arc for the source itself. This arc lamp gives an illumination of a brightness five times the intrinsic brightness of the best tungsten filament bulb. It is an ideally symmetrical light source with no flicker.

The condenser optics are such as to produce an almost perfect parallel beam of light. There is, therefore, no loss in intensity with distance of the objective lens from the condenser unit. Optics for a condenser unit of this type are known to be commercially available. A reflecting mirror can be moved 18 in. in a parallel beam without a change in focus of the mercury arc itself.

It is proposed that the parallel beam direction be changed by a 45 deg mirror to direct the beam into the pickup objective. This mirror would travel in the parallel beam with the pickup microscope X motion, using a servo or mechanical system. Following the turning of the beam into the pickup objective, a lens system may be required to focus the mercury arc onto the objective in a modified Köhler form of illumination. The unusual intensity of this source, however, may make this unnecessary even though the beam width may exceed the objective aperture.

The condenser unit is well air-cooled and is mounted so it will not contribute heat to comparator parts. Cold mirrors and heat absorbing glass will also be used in the optical path to eliminate, as it is possible to do so, wavelengths above the visible region of the electromagnetic spectrum. Either an iris or crossed polaroid system will be used to vary the intensity of the illumination.

Substage backlighting with fluorescent lamps will be provided.

3.2 Pick-Up Optics.

An approximately 0.57X image of the plate will first be relayed to a primary image focal plane, the precise magnification to be determined in the course of the development. See paragraph 2.1. At this focal plane will be placed the measuring reticle of pattern to be determined (paragraph 2.6).

The reticle focal plane will be viewed by a standard [REDACTED] binocular Dynazoom pod. Adjustment will be provided to bring the reticle into fine focus.

Fine focus of the plate for the right eye is then made by moving the entire optical system or elements of it. (Section 2.5). Adjustment of the left ocular will bring the image into fine focus for both eyes.

A calibration for pod position will be supplied for the convenience of different operators.

In so far as possible, standard microscope optics of high quality American manufacture will be used.

4. COMPETENCE

The [redacted] in over 28 years of experience in the design and fabrication of precision measuring instruments has developed a competence without equal in the field of optical-mechanical metrological instrumentation. This particular work should be performed by the [redacted] as the original manufacturers of the instruments to be modified. Unforeseeable harm can be done by well intentioned but unfamiliar designers to such sensitive instruments as these, designed for extreme stability and the very minimum deflection so as to realize an accuracy of the order of 1μ or 0.001% of the travel, whichever is the larger. Machining will be required for mounting the new optics, possibly requiring the disassembly and reassembly of critical components. The [redacted] would be remiss in its responsibility if it did not invite the attention of the Navy Department to the possibilities of harm to these refined pieces of instrumentation by those unfamiliar with the problems involved.

Résumés of [redacted]
[redacted] are included. These technical managers are well supported by several senior engineers with many years of experience in the field of instrumentation for precision measurement.

Next 5 Page(s) In Document Exempt

5. FACILITIES

The [REDACTED] contains over 12,000 square feet and is equipped with environment-controlled areas to perform product manufacturing where temperature, dust, and humidity control is required. The functions of engineering, manufacturing, assembly, and test are separated, and the mechanical and electronic departments are equipped with advanced machinery and tools to meet the requirements of custom design and production work. Circular and linear ruling operations on glass and metals are performed to unusual degrees of microscopic accuracy. This is possible through the use of special production equipment which is not available elsewhere--equipment such as a precision circular dividing engine, linear dividing engines and high precision grid ruling equipment.

Closely associated with the [REDACTED] are the scientists and engineers of the [REDACTED] located with the corporations main offices. This building contains 30,000 square feet of offices and special laboratories for research. Supporting facilities exist here for optical and electronic engineering, data reduction, and precision testing and calibration.